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ABSTRACT

The purpose of this investigation was to assess biofeedback (BF) and progressive muscle relaxation (PMR) and placebo-control training by means of a post-training transfer test. The subjects for the research were 30 women. Initial tests consisted of measuring the electromyographic response of the frontalis muscle of the forehead to stress. After the test procedures were completed, training sessions were conducted. BF subjects were instructed to use a feedback tone as a guide for relaxation. PMR subjects heard progressive relaxation instructions that were modified so that the majority of the training instructions were directed specifically to the frontalis muscle. The group of subjects receiving placebo training listened to a short, taped presentation on the benefits of relaxation after which they heard music that fluctuated in volume and tempo. Results showed that both BF and PMR training reduced resting electromyography significantly more than the placebo-control procedure. BF subjects had significantly greater reductions following training than either the PMR or control groups. (JD)

STRESS TESTING RECOVERY EMG FOR EVALUATION OF BIOFEEDBACK AND PROGRESSIVE MUSCLE RELAXATION TRAINING EFFECTS *

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ABSTRACT

The effectiveness of EMG biofeedback (BF) and progressive muscle relaxation (PMR) in reducing muscle tension during laboratory training sessions has been well established. However, the transfer effects of these procedures outside the training session are not well understood. The purpose of this investigation was to assess BF, PMR and placebo control training via a post-training transfer task. The measurement consisted of 3 ten-second EMG data points taken on the frontalis muscle during recovery after a ten-second period of voluntary tension production of that muscle. Thirty female subjects were tested before and after four sessions of either: BF, PMR or a placebo-control procedure which involved listening to music as an alleged guide for relaxation. The results showed that BF patients exhibited significantly lower recovery EMG values than PMR or placebo-control patients. Mean EMG values post-training during the first 10 seconds of recovery for BF, PMR and placebo-control groups were: 13.6, 18.6 and 21.4 uvolts/min., respectively. Results were similar for the second and third ten-second periods. These results suggest that BF training may be more effective than PMR or placebo-control training in enhancing the patient's ability to eliminate muscle tension quickly and completely following voluntary tension production.

Introduction

Numerous studies have reported the effectiveness of EMG biofeedback and progressive muscle relaxation in reducing muscle tension in the resting state after training (Reinking and Kohl, 1975; Cox, Freundlich and Meyer, 1975; Canter, Kondo and Knott; Budzinski and Stoyva, 1969; Sime and DeGood, 1977). However few studies have analyzed the post training transfer task results. To adequately evaluate transfer of relaxation skill outside the training situation, it would be desirable to utilize a task which is functionally relevant. In other words the task should test the subject's ability to eliminate muscle tension quickly and completely following a voluntary muscle contraction which the subject might perform routinely in day-to-day activities. The purpose of this investigation was to compare the EMG measurements during a 30-second recovery period following volunary tension production before and after EMG biofeedback, progressive muscle relaxation and a placebo-control procedure.

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Subjects

Thirty female subjects, age 22-47 years (mean = 28.3 years) were selected for this investigation. Subjects were recruited from a university community (students, faculty and administration) by advertisement of an experimental relaxation program for "nervous, tense" individuals. Since the majority of the initial respondents were female, it was decided to proceed with a homogenous population. All prospective subjects reported some symptoms suggestive of excessive muscle tension but were not currently under treatment for medical or psychiatric illness. Selection of subjects was further based on the following criteria. Subjects agreed: (1) to complte all testing and training sessions, (2) to maintain routine lifestyle without change during the training and (3) to accept whatever training method was specified according to randomization.

Apparatus

EMG activity from the frontalis muscle was processed by a Coulbourn Instruments high gain bioamplifier/coupler and integrated for digital display. The feedback signal to the subject was a variable tone which cut-out below a given threshold. The threshold was adjusted so that approximately 50% of the time the tone was absent indicating to the subject that frontalis muscle tension was low. Low and high frequency filter settings were at 90 and 1000Hz, respectively. Digital EMG data was recorded in units calibrated to uvolts/minute, peak-to-peak.

Bipolar surface electrodes (Beckman) were placed approximately one inch above the eybrow and one and one-half inches on either side of the midline. A ground electrode was located directly above the nasion. The skin surface was cleaned thoroughly with alcohol and the electrode sites were abrased lightly with fine grade sandpaper. Resistance between electrodes was always less than 10K. The raw EMG signal was monitored continuously on an oscilloscope for presence of artifact or electrical interferences.

Testing and training sessions were conducted on subjects individually in a sound-proof, electrically-shielded room. The subjects were seated, semi-recumbent in a recliner chair and wore headphones during all of the procedures. The experimenter and instrumentation were located in an adjacent room. All testing and training instructions were standardized and presented on tape.

Design and Procedure

Before and after training the following test procedures were administered. After a ten-minute rest period, baseline EMG measurements were taken and subjective awareness of frontalis muscle tension was determined according to methods described previously (Sime, DeGood and Noble, 1975). A tension production test was administered to all subjects. It consisted of a magnitude production task whereby the subject was instructed to associate resting baseline state with 0% tension and raising the eyebrows maximally with 100% tension. The subject was then asked to produce in random order 10,

20, 30, 40, 50, 60, 70, 80 and 90% tension each for 10 seconds with a 30-second recovery period between trials. Three 10-second periods of EMG measurements were taken during the recovery period. Mean recovery data from all nine trials was recorded and analyzed in EMG counts/10 sec. recovery period for 0-10 seconds, 11-20 seconds and 21-30 seconds. Subsequently, a conversion to EMG uvolts peak to peak was made.

Relaxation training. After the initial test procedures were completed the first of four training sessions was begun. Subjects were randomly assigned to EMG biofeedback (BF) training, progressive muscle relaxation (PMR) training, or a placebo-control procedure in which subjects listened to music as an alleged guide for relaxation. BF subjects were instructed to use the feedback tone as a guide for relaxation. PMR subjects heard progressive relaxation instructions (Jacobsen, 1938) which were modified so that the majority of the training instructions were directed specifically to the frontalis muscle of the forehead. In addition some instructions were directed to the other facial muscles since adjacent muscles influence the electrical activity recorded from the frontalis muscle electrode placement.

The group of subjects receiving placebo training listened to a short taped presentation on the benefits of relaxation after which they heard music which fluctuated in volume and tempo. An elaborate, but fabricated, explanation of how the physiological functions of the body would fluctuate if they attended to the music was presented to the subjects in order to convince them that meaningful training was being administered.

The training program consisted of four separate sessions over a ten-day period. The duration of training sessions was 15 minutes for the first and last sessions and 30 minutes for the second and third sessions. EMG data was collected throughout training as well as during testing pre- and post-training.

Results

The results for resting EMG changes reported previously (Sime, DeGood and Noble, 1975) showed that both BF and PMR training reduced resting EMG significantly more than the placebo-control procedure. The results for recovery EMG (figure 1) following voluntary tension production showed that the BF subjects had significantly greater reductions following training than either the PMR or control groups. An ANOVA between groups pre- to post-training showed a significant difference at: 0-10 seconds, $F(2/27) = 4.29$, $MSe = 5.58$; 11-20 seconds, $F(2/27) = 4.58$, $MSe = 3.98$; 21-30 seconds, $F(2/27) = 4.53$, $MSe = 3.43$. The mean recovery EMG values at 0-10 seconds pre- to post-training were: 24.0 and 13.6 uvolts/min. for BF subjects, 23.7 and 18.6 for PMR subjects and 23.3 and 21.4 for placebo-control subjects. Post-hoc analysis showed that only the BF group was significantly lower after training, $F(1/27) = 12.57$. Similar results were observed at 11-20 seconds and 21-30 seconds of recovery. Figure 2 shows the progressive decline in recovery EMG for 0-10, 11-20, and 21-30 seconds in all three groups post-training. A significant

decrease from pre-training values was observed in all three recovery periods for the BF group alone. There was no significant difference between groups for the EMG data during the tension production task.

Discussion

The results of this experiment have demonstrated the discriminating potential of a post-training transfer task in assessing the effectiveness of relaxation training. The transfer task was part of a magnitude production test that was designed to assess the accuracy of tension production (10, 20 ... 90% of maximum) after training. No significant differences between groups were observed in the magnitude production procedure. However the recovery EMG data following tension production was most encouraging. Whereas, both BF and PMR training had shown significant reductions in resting level EMG, the recovery data demonstrated that only BF training was effective in the post-training transfer task. This transfer task (recovery EMG) was thought to be a new development in assessing the functional effectiveness of relaxation training for efficient performance of routine, day-to-day tasks. The validity of this task, however, has not yet been determined.

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FIGURE 1. PRE- AND POST-TRAINING FRONTALIS EMG (RECOVERY) 0 - 10 SECONDS IMMEDIATELY AFTER A VOLUNTARY TENSION PRODUCTION TASK FOR EMG BIOFEEDBACK, PROGRESSIVE MUSCLE RELAXATION AND PLACEBO CONTROL GROUPS (N = 10/GROUP)

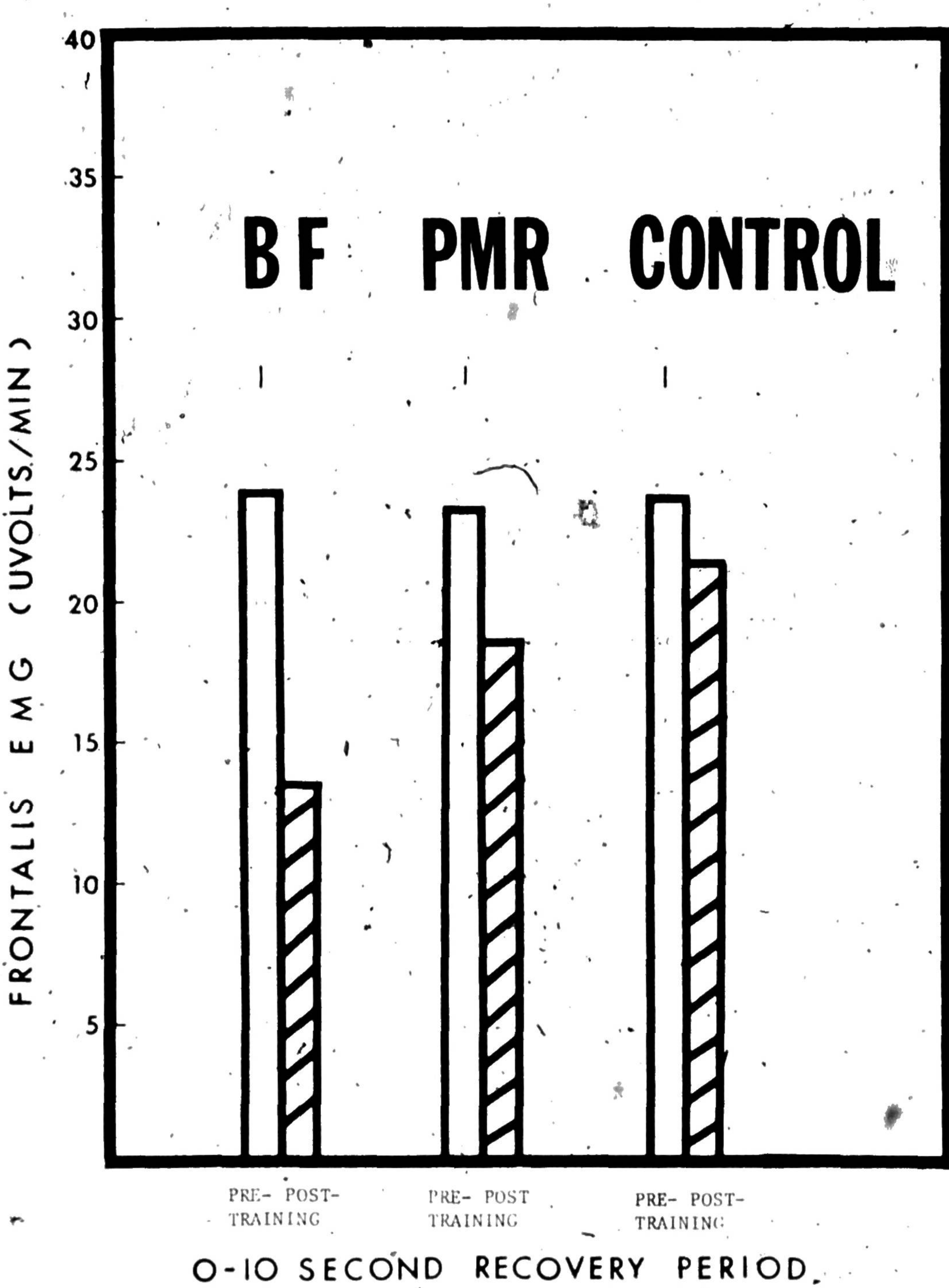
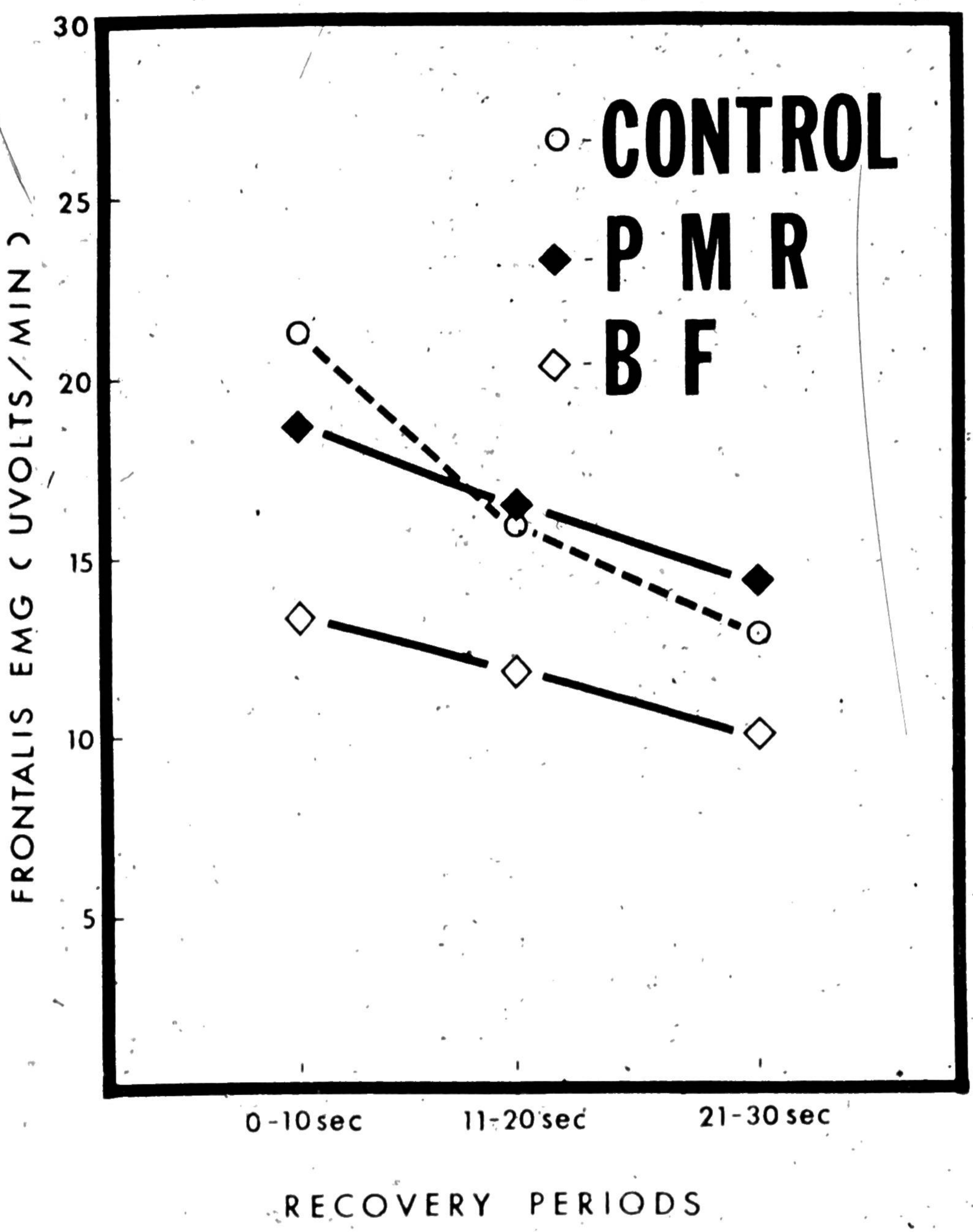


FIGURE 2. POST-TRAINING FRONTALIS EMG (RECOVERY) 0 - 10 11 - 20 AND 21 - 30 SECONDS AFTER A VOLUNTARY TENSION PRODUCTION TASK FOR EMG BIOFEEDBACK, PROGRESSIVE MUSCLE RELAXATION AND PLACEBO-CONTROL GROUPS (N - 10/GROUP)*



*NO SIGNIFICANT DIFFERENCE BETWEEN GROUPS FOR INITIAL VALUES PRE-TRAINING